CHAPTER 4 : DIET OF LEOPARDS IN TWO AREAS OF THE WATERBERG.

INTRODUCTION

Because of their predation on livestock and the subsequent additional economic burden placed on farmers, the habits of leopards are receiving more attention. Not only are stock losses of many thousands of rands occurring annually on cattle ranches, but the fast growing game-ranching industry is becoming increasingly concerned about the presence of these predators.

Leopards are known to be preying on a wide spectrum of animals including birds, fish, reptiles, small mammals and larger herbivores of more than twice their own body mass, as well as carrion (Turnbull-Kemp 1967 ; Grobler & Wilson 1972 ; Schaller 1972 ; Hamilton 1976 ; Bothma & le Riche 1984 and Norton, Lawson & Avery 1986). This ability to use virtually any potential prey animal they may encounter, results in frequent incidents of stock raiding in farming areas.

Because of their secretive nature, much qualitative information is still lacking regarding prey preference, particularly in stock farming regions.

In general, a correlation can be drawn between ecological factors such as prey size, distribution and density, and the social systems of felids. These factors influence the social interactions and movement patterns of individuals, and hence shape the overall social organisation of the population (Sunquist 1981).

It is furthermore important to gain more knowledge about methods of capture as well as feeding behaviour of leopards to enable effective protection measures for livestock to be adopted as part of a conservation strategy for leopards.

OBJECTIVES

The objectives of the investigation were :

a. To examine the diet (prey items) of leopards in two areas of the Waterberg (Naboomspruit, Melk River), relative to prey abundance.

b. To investigate prey capture and feeding behaviour of leopards, especially pertaining to domestic livestock.

c. To determine prey item utilization in terms of quantitative consumption during a night feeding session and the utilization of carcasses over a period of time.

METHODS

Prey_abundance

The number of large ungulates () steenbok) were obtained from non-sampling methods provided by game farmers. This was based on systematic search (total) counts and known group counts (Collinson 1985).

In the case of the Doorndraai Dam Nature Reserve (TPA), census data were provided by the Transvaal Division of Nature and Environmental Conservation. This information was also based on systematic search counts and known group counts

(Coetzee pers comm)*. Own observations and verified opinions of farmers were used in the case of small mammals. Small mammals are given only as common or rare.

Prey_items

Leopard scats (n=76) were collected (June 1985-June 1987) in both study areas, along farm roads and in areas frequently used by leopards. Each sample was kept separate in a paper bag, later transferred to a small nylon bag and washed in a commercial clothes washer (Defy Automaid, Defy Corporation Limited, Johannesburg R.S.A.) untill all soluble material was removed. The contents of each bag were emptied onto a glass tray and food items identified.

Leopard and brown hyaena faeces were distinguished using general morphology (e.a. segment length, colour) and especially associated tracks and scrapes. Leopard scats with their typical cat-like "segmented" appearance were considered as doubtfull when less than 20 mm in diameter. This was necessary due to the presence of caracals in the study area. Most food items in scats, and remains at den sites were identified using cross-sections of hairs that were compared to

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photographic reference material.

This photographic reference collection was compiled by collecting reference material (hairs) from various parts (flanks, mane, belly and rump) of mammal skins collected in the veld, stored at the Transvaal Museum and made available by a taxidermist (N van Rooyen, Taxidermist, Rosslynn, Pretoria). In addition, other reference collections from photographs were made available for comparison (J.D. Skinner, H. Keogh and J. du P. Bothma).

The identification of ungulates, carnivores, primates, lagomorphs and other larger rodents (>1kg) were to species level, whereas smaller rodents, reptiles, birds, insects and plants were only identified as such. When no hairs were present in a scat the origin was recorded as unknown. Additional information was obtained from investigations of 40 leopard kills of which 19 were cattle calves.

Prey capture and feeding behaviour

Information regarding cattle predation behaviour was collected by visiting farms where cattle losses occured (n=19). Capture site in relation to nearest human activity, calf age, calf sex, method of killing and method of feeding were recorded. Investigations of 22 ungulate carcasses (excluding cattle calves) revealed futher information regarding prey age, sex, food concealment behaviour, method of killing and feeding behaviour.

Food consumption

The quantity of meat consumed by a male leopard weighing, 60,5 kg during each of 12 feeding nights of 12 hours where three cattle calves were the prey was measured. Six nights were recorded during winter (June) and six in summer (December). All four legs and the head of a carcass were separately fastened to a tree trunk, thus preventing the leopard tearing parts off a carcass and dragging it away.

RESULTS

Prey abundance

The mammal fauna (>1kg) in the Melk River area consisted of 24 species of ungulate, 18 carnivore species (including cat *Felis catus* and dog *Canis familiaris*), two species of primates, two of lagomorphs, one tubulidentate, one pholidate, three rodent species and one hyracoid (Table 2). Livestock occurring in these areas were cattle, donkeys, sheep and goats, these and to a lesser extent all other vertebrates in the area, were regarded as potential food items for the brown hyaena. The mammal fauna (>1kg) in the Naboomspruit study area consisted of 19 ungulate species, 18 species of carnivores (including domestic cat and dog), one hyracoid, two primates, two lagomorphs, one tubulidentate, one pholidate and three rodent species (Table 2).

Table 2: Species and abundance of the mammalian fauna (>1kg) in the Melk River (1985-1986) and Naboomspruit (1986-1987) study areas.

Species	Abundance	
Ungulates	Naboomspruit	Melk River
Ceratotherium simum	0	12
Giraffa camelopardalis	6	0
Taurotragus oryx	0	70
Equus burchelli	55	200
Equus zebra hartmannae	0	10
Hippotragus equinus	37	28
Kobus ellipsiprymnus	57	200
Hippotragus niger	29	6
Connochaetes taurinus	100	80
Alcelaphus buselaphus	8	195
Tragelaphus strepsiceros	200+	400+
Tragelaphus angasi	0	10
Damaliscus lunatus	118	0
Oryx gazella	0	82
Tragelaphus scriptus	50+	80+
Redunca arundinum	50+	40+
Redunca fulvorufula	100+	200+
Aepyceros melampus	500	1300
Damaliscus dorcas phillipsi	20	55
Sylvicapra grimmia	C	C
Raphicerus campestris	C	C
Oreotragus oreotragus	100+	200+
Phacochoerus aethiopicus	C	C
Potamochoerus porcus	C	C
Bos spp. (cattle)	C	C
Equus asinus (donkey)	C	R
Ovis aries (sheep)	C	R
Capra hircus (domestic goat)	C	R
OTHER		
Procavia capensis	C	R
Papio ursinus	C	C
Cercopithecus aethiops	C	C
Canis familiaris	C	R
Felis catus	C	R
Felis serval	R	R
Felis caracal	C	C
Proteles cristatus	R	R
Aonyx capensis	R	R
Lutra maculicollis	R	R
Canis mesomelas	C	C
Genetta genetta	C	C
Genetta tigrina	C	C
Atilax paludinosus	C	C
Panthera pardus	R	C
Hyaena brunnea	C	C
Mellivora capensis	R	C

Ichneumia albicauda	R	R
Civettictis civetta	R	R
Mangos mango	C	C
Ictonyx striatus	R	R
Orycteropus afer	C	C
Lepus saxatilis	C	C
Pronolagus randensis	C	C
Hystrix africaeaustralis	C	C
Thryonomus swinderianus	C	C
Manis temminckii	R	R
Pedetes capensis	C	C

Table 3: Leopard diet in two areas of the Waterberg as determined by scat analysis (% of occurrence). Carcass observations are in parenthesis.

SPECIES	MELK RIVER SCATS (n=39)		NABOOMSPRUIT SCATS (n=37)		TOTAL	
UNGULATES	N	%	N	%	N	%
CATEGORY I (> 60 Kg)						
Bos spp.	1(8)	2,5	2(11)	5,4	3(19)	3,9
Equus burchelli	2(1)	5,1	0(0)	0	2(1)	2,6
Hippotragus equinus	0(1)	0	0(0)	0	0(1)	0
Tragelaphus strepsiceros	2(0)	5,1	3(0)	8,1	5	6,5
Connochaetes taurinus	0(0)	0	2(0)	5,4	2	2,6
Alcelaphus buselaphus	1(0)	2,5	0(0)	0	1	1,3
CATEGORY II (< 60 Kg)						
Damaliscus lunatus	1(2)	2,5	0(0)	0	1(2)	1,3
Tragelaphus scriptus	2(1)	5,1	1(1)	2,7	3(2)	3,9
Aepyceros melampus	13(6)	33,3	7(2)	18,9	20(8)	26,3
Redunca fulvorufula	1(1)	2,5	1(0)	2,7	2(1)	2,6
Potamochoerus porcus	1(0)	2,5	1(0)	2,7	2	2,6
Potamochoerus aethiopicus	2(0)	5,1	2(0)	5,4	4	5,2
Capra hircus	1(2)	2,5	0(0)	0	1(2)	1,3
Oreotragus oreotragus	2(2)	5,1	1(0)	2,7	3(2)	3,9
Raphicerus campestris	0(0)	0	2(1)	5,4	2(1)	2,6
Sylvicapra grimmia	1(1)	2,5	3(1)	8,1	4(2)	5,2

	N	%	N	%	N	%
UNGULATE TOTAL:	30(25)	76,3	25(16)	67,5	55(41)	72,3
OTHER :	N	%	N	%	N	%
Papio ursinus	0(1)	0	0(0)	0	0(1)	0
Panthera pardus	0(0)	0	1(0)	2,7	1	2,6
Canis mesomelas	1(0)	2,5	1(0)	2,7	2	2,6
Galerella sanguinea	2(0)	5,1	1(1)	2,7	3(1)	3,9
Pronolagus randensis	1(0)	2,5	1(1)	2,7	2(1)	2,6
Lepus saxatilis	2(0)	5,1	3(0)	8,1	5	6,5
Procavia capensis	3(0)	7,6	0(0)	0	3	3,9
Tryonomus swinderianus	1(1)	2,1	2(0)	5,4	3(1)	3,9
Otomys spp.	0(0)	0	1(0)	2,7	1	1,3
Mice Spp.	1(0)	2,5	2(0)	5,4	3	3,9
Birds	0(0)	0	1(0)	2,7	1	1,3
Unknown	2(0)	5,1	2(0)	5,4	4	5,2
TOTAL:	13(2)	35,8	15(2)	40,5	28(4)	36,8

Scat analysis

The percentage of scats (total occurrence) containing identifiable food items for the two areas is presented in Table 3.

The opportunistic feeding habits of leopards were also apparent in this study. Apart from ungulates, a range of other prey from baboons to small rodents and birds were preyed upon.

Melk River study area :

Ungulate hair was found in 76,3 % of the scats collected in this area. Impala were by far the best represented, at 33,3 % . Burchell's zebra, kudu, warthog and klipspringer hairs were each recorded in two scats, while red hartebeest, blesbok, mountain reedbuck, bushpig, duiker and domestic goat remains were present in one scat each. Cattle hair was present in one scat.

Carcasses found included a yearling roan antelope calf, a newly born zebra foal, six impala carcasses (one subadult male, five adult females), two subadult female blesbok, one adult female bushbuck, an adult male mountain reedbuck, an adult male duiker, two adult klipspringer (sexes unknown) and two domestic goats. In addition, corpses of eight cattle calves were confirmed to have been killed by leopards.

Ages of the calves differed from newly born to 103 days old, with an average age of 22 days. Sexes were evenly represented.

Mammals other than ungulates featured in 35,8 % of the scats collected in the Melk River area. Three scats contained rock dassie hair, two scats scrub hare while slender mongoose remains were found in two scats.

A black backed jackal, Jameson's rock rabbit, cane rat and rodent were recorded once. Two scats were discarded in that the contents could not be ascertained. Carcasses of a subadult baboon (sex unknown) and a cane rat were found.

Naboomspruit study area :

In this area, 67,5 % of the scats contained the hair of an ungulate, of which impala contributed 18,9 %, kudu and duiker both 8,1%, while blue wildebeest, warthog, steenbok and cattle were each found in two scats. Bushbuck, mountain reedbuck, bushpig and klipspringer were found once.

Investigations in this study area revealed the presence of the carcasses of two impala (adult male and female), female bushbuck, adult steenbok (sex unknown) and a duiker male. Leopards took 11 cattle calves over a period of 11 months (September 1986- July 1987). The ages of the calves varied from new-born to 90 days old, with an average of 21 days (n = 11) (SD = 10). Five individuals were bull-calves while four were heifers.

Mammals other than ungulates featured in 40,5 % of the scats. Scrub hare remains were found in three scats, while cane rat and rodent hair (species unknown) occurred in two scats each. Black backed jackal, Jameson's red rock rabbit, slender mongoose and vlei rat only occurred once. Only one scat contained the feathers of an unknown bird. Remains of a Jameson's rock rabbit and a slender mongoose were also found.

Table 4 : Percentage occurrence (n=76) of different prey groups represented in leopard scats in the Melk River and Naboomspruit study areas.

GROUP	SCATS (N=76)	% OCCURRENCE
UNGULATES :		
Category I (> 60Kg)	13	17,1%
Category II (< 60Kg)	42	55,2%
UNGULATE TOTAL:	55	72,3%
Hyracoids	3	3,9%
Rodents	7	9,2%
Lagomorphs	7	9,2%
Birds	1	1,3%
Carnivores	6	7,9%

Prey capture and feeding behaviour

Capture locality :

In the 19 cases of where calves were taken only one was killed in a kraal in the presence of other cattle. This happened on the farm Rooikoppies, district Brits, in August 1985, only one kilometer from human activity. Three calves were taken in open veld close to farmhouses (<800m) in different localities in the Waterberg, while the remainder (n=15) were taken in mountainous veld (rocky areas) far (>2 km) from human disturbance. All 19 calves were in the company of cows, or at least in their near vicinity. Antelope carcasses (21) were found far from human activity.

Method of killing :

All ten of the calves killed, where the throat and neck were not already consumed, showed teeth marks occurring as haemorrhaging under the skin. In cattle calves younger than five weeks (n=7) all were by bites through the nape of the neck. In ages between six and 12 weeks (n = 3), one was strangled (nine weeks old), and the other two were possibly suffocated (10 - 11 weeks old). Claw marks were also present on the shoulder blades of both the latter calves.

In the Melk River area, four antelopes (a roan antelope calf, three adult female impala) were killed by suffocation. Both domestic goats were killed by their necks being fractured. In an impala (adult female) and steenbok (sex unknown) examined in the Naboomspruit area, teeth marks were found in their neck and throat regions.

Drag distance :

Following killing, drag distances (cattle calves) showed considerable variation, varying from 20m to 1005m with an average of 220m (n = 10). No differences between season or correlation between prey weight and drag distances were apparent. Second night drag distances varied from 0 - 350 m (n = 8). First night (capture night) drag distances of two impala females measured 416 and 1115 m.

An adult blesbok female was dragged 426 m after capture. Due to advanced consumption and rainy weather it could not be ascertained whether the blesbok was killed the previous night or two nights before. Drag marks of a klipspringer carcass was tracked for 725 m but the carcass could not be located.

Method of feeding :

In ten kills investigated after the first night of feeding (killing night), radio-collared male A started by opening the belly in five cases, consuming the abdomen and eating away the end of the ribs. No discarded paunches were found and it was assumed that they were eaten entirely. All these calves were younger than five weeks.

In three of the five cases the intestines (liver and heart) were partly consumed. The first night feeding patterns of the same leopard in the remaining five cases, consisted in four cases of eating the hindlegs between the thighs, and in the remaining case eating the brisket. In another eight cases where different leopards were involved (different regions in the Waterberg and therefore presumed to be different individuals), five cattle calf carcasses were initially consumed by opening up the belly and eating the entrails. In the remaining three instances, initial consumption started between the thighs (n = 2) and in the chest region (n = 1).

In the case of adult impala, bushbuck, klipspringer and goat carcasses found in the Melk River area, no heads, vertebrae, femurs, tibia or hooves were consumed. In younger antelope (subadult impala male, roan calf) and a zebra foal however, only hooves, femurs and parts of the vertebrae were found. No carcasses of cattle calves were monitored up to the end of consumption in this area. In the Naboomspruit area however, the radio-collared male on one occasion consumed a whole cattle calf (two months old). Only the molars and hooves were left. Hair plucking was recorded in two carcasses of cattle calves and two carcasses of impala taken in the Melk River area but only on a cattle calf in the Naboomspruit area.

Hiding behaviour :

In only one instance was prey (zebra foal) hoisted into a tree (Burkea africana). In another five cases, the carcasses were only dragged away. The leopard did however, return the following night to feed. In thirty five cases carcasses were taken into dense scrub cover. Of these, six were covered with leaves and twigs.

Consumption :

The first calf that was weighed following successive feeding nights was killed on 2 December 1986, on the farm Baviaanspoort (Naboomspruit study area). During the first night only the abomasum and parts of the intestine were eaten. The calf weighed 45,5 kg at that stage. During the second and third nights 10,1 kg and 8,2 kg were consumed respectively, followed by 9,5 kg on the fourth night. Unfortunately, the remainder of the carcass was removed by the leopard on the fifth night and the remnants could not be found. An average of 9,2 kg was therefore consumed per night. This radio-collared leopard moved out of the area during the sixth night. The second calf was killed by the same leopard during the night of 12 December 1986, also on the farm Baviaanspoort. During the night of capture approximately one kg of meat was consumed from the groin area. When fastened against a tree the calf weighed 39,2 kg. During the second and third nights the leopard consumed 10,8 and 9,3 kg of meat respectively. The fourth night a further 8,6 kg was removed. The leopard did not, however, return again and the remains (head, tibia and hooves) were consumed by black backed jackals. An average of 9,6 kg of meat was therefore consumed during this period per feeding night. On the evening of 3 June 1987, another calf was taken by the same individual on the farm Cyferfontein.

When discovered the next morning, approximately two kg had been eaten from the breast region. The second night 6,8 kg was consumed, followed by 5,6 kg, 6,0 kg and 5,1 kg of meat on successive nights. During the sixth and seventh nights 4,8 and 4,2 kg meat was eaten. The remains (head and left tibia) were loosened and carried away by the leopard on night eight. The leopard left the area during night nine. An average of 5,4 kg meat was consumed during this period per feeding night.

DISCUSSION

Methods used in the past to determine prey species utilized by leopards differ from indirect observations (Bothma & le Riche 1984) in the southern Kalahari, to direct observations in Kenya (Hamilton 1976), in the Serengeti (Bertram 1980), and in the Transvaal Lowveld (le Roux & Skinner 1989). Although some of these studies were supplemented by means of scat analysis in determining diet, most studies have had to rely solely on information gained by scat analysis (Grobler & Wilson 1972 in Zimbabwe; Smith 1977 in Zimbabwe; and Norton et al. 1986 in the Cape Province).

Due to their stealthy habits, Waterberg leopards could only be studied indirectly primarily through scat analysis and tracing kills in identifying prey items. Prey availability rather than mere prey biomass are important to a predator.

In a prey abundance scenario, the food available to a leopard is influenced by prey size, physical condition, habitat type, social structure and aggression and mortality agents (Kruuk 1986). Prey size as a function of prey availability has been documented in studies all over the leopard's range.

In the Waterberg the majority of scats contained the remains of ungulates (72,3%). Those weighing less than 60 kg (Category II), contributed 55,2%. It is however most likely that sub-adults of species weighing more than 60 kg were involved, or that mortality agents of some kind were present in the case of adult individuals. Unfortunately hair identification does not reveal information regarding age of prey but in observations on carcasses (kills), where adults weigh >60 kg, both kills were juveniles.

Bothma & le Riche (1984) also found a clear preference for medium sized mammals in the southern Kalahari in both male and female leopards. Prey larger than adult springbok was caught infrequently. This agrees with observations on leopard diet in Tanzania (Kruuk & Turner 1967), Zimbabwe (Grobler & Wilson 1972; Smith 1977), the Transvaal Lowveld (le Roux & Skinner 1989) and the Cape Province (Norton et al. 1986). It also supports the suggestion by Seidensticker (1976) that prey size is important in prey selection by leopards. In natural and relatively stable ecosystems, felids, in common with many other carnivores have little effect on the numbers of individuals in prey populations (Sinclair 1979, Hornocker 1970). However there can be effects of predation on the age-composition of prey populations or their physical condition.

Cougars did not select for age amongst mule deer Odocoileus hemionus, but amongst elk they preferred young animals (Hornocker 1970). Feral cats and European wildcats also select young rabbits, and rabbits suffering from myxomatosis (Corbett 1979; Liberg 1981).

Prey size as a function of prey availability in the leopard is also of great importance in a cattle protecting strategy (see Chapter 6), as only calves up to four months are vulnerable to leopard predation. Habitat type can also have an important effect on the availability of certain prey species to felids (Kruuk 1986).

The evidence that hunting success is highly dependant upon the amount of available cover (Schaller 1972 ; Hornocker 1970 ; Corbett 1979) supports the assumption that the number of places where prey can be successfully stalked by predators is limited (Kruuk 1986). In the southern Kalahari Bothma & le Riche (1989), furthermore, recorded optimal positioning in the leopard whereby potential prey were selected from a high vantage point. Thus confirming the concept that cover and sight play an important role in hunting by cats (Eltringham 1979 ; Kruuk 1986).

Certain features can however further assist the predator. In the Waterberg all game ranches are game fenced. The amount of available prey in the territory of each leopard is therefore constant over the seasons. These farms are furthermore stocked with various game species, which are forced to use sub-optimal dense and rocky mountain veld during certain periods of the year. This favours the hunting techniques e.g. stalking and ambushing used by leopard.

Especially plains and open savanna species like blesbok, impala, Burchell's zebra and red hartebeest would be vulnerable to leopard predation under such conditions.

Although the abundance of impala in the two study areas could account for the high percentage of impala remains (33%) in leopard scats, the rocky habitat definitely favoured the hunting techniques of leopards. Only one scat contained the remains of a blesbok. This could be due to the relatively low number of blesbok in the study area. However on two farms Klipfontein and Lady Grey, blesbok populations showed a growth rate of 6,0 and 8,0 % respectively. The role of predation couldn't be excluded. In two African National Parks, Nairobi and Kruger, predation by lions caused a serious decline in wildebeest populations, after man had interfered by putting in fences and by changing the grass burning regime (Rudnai 1974 ; Smuts 1978). In both cases wildebeest were forced to graze in longer grass, and were therefore more vulnerable to lion predation than previously. Gibb, Ward & Ward (1978) described the almost complete extinction of a (fenced) rabbit population by feral cats in New Zeeland. Although baboons were common in the study area no scats contained baboon remains. Only one carcass, killed by a leopard was found. It has been suggested that baboons are able to avoid predation by leopards, probably due to their co-operative mobbing behaviour (Pienaar 1969). This view is also shared by Hamilton (1981) in Kenya and Norton <u>et al</u>. (1986) in the Cape Province. Hamilton (1981) is of the opinion that leopards do take baboons, particularly the young when they get the opportunity, and therefore apparently have some effect on their populations. He however believes the effect to be exaggerated.

Leopards may nevertheless have an important effect on selection of resting places, and therefore movements of baboon troops (Smithers 1983). Some leopards are known to specialize in hunting baboons, as in Kenya (Simons 1966). This is probably for the very good reason that little other food is available for leopards, as capture is not without risk. The formidable canine teeth of baboons are capable of inflicting real damage on a predator.

Over the period February 1985 to December 1987 one leopard was known to have been killed in the Waterberg by baboons. The leopard was torn to pieces at the Police Training Terrain at Rankins Pass (25° 15'S 30° 30'E) in December 1986.

There are also idiosyncrasies, the origin of which is quite obscure. Estes (1967) noted an individual leopard addicted to killing black backed jackals. Bothma & le Riche (1984) also reported on the development of individual taste in a southern Kalahari leopard. A male leopard killed six times in 12 days, four of the kills being porcupines ambushed as they emerged from their burrows.

Bothma & le Riche (1989) furthermore presented data which imply that the varied reaction of leopards to their prey may be related to past experiences. Gemsbok, probably the most

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aggressive prey of leopards in the southern Kalahari and known to have killed lions, spotted hyaenas and leopards (Eloff 1973) are approached carefully. Leopards respond by elaborate stalking and even optimal positioning, especially when hunting a gemsbok calf attended by a cow. This varied hunting approach to different prey types thus supports the concept that leopards exhibit individual variation in hunting technique as suggested by Leyhausen (1979) for cats in general and by Schaller (1972) for lions. This variation may be based on differences between the sexes, or related to social rank.

Many game ranches in the Waterberg are also overstocked with game. Leopards may be more selective among relatively large prey (unavailable) in cases where these prey categories suffer from limiting factors such as hunger and disease. The manifestation of disease in such stressful situations is well known (Lightfoot & Norval 1981).

As an important scavenger (Turnbull-Kemp 1967 ; Hamilton 1981) leopards are favoured when mortality agents (e.g. diseases etc.) are present, which make large unavailable prey available. As scavengers they will feed on animals such as elephants (Hamilton 1981), and litter around deserted camps (Turnbull-Kemp 1967).

In the Melk River study area, on the farm Sliedrecht, leopards attacked wounded animals on two occasions. In both cases the impala was wounded but efforts to find him were abandoned at dusk. These animals were located the next day, killed (teeth marks around throat) and partially consumed by a leopard. Turnbull-Kemp (1967) even noted the fact that leopards have been attracted by shots, knowing these to mean potential food, in Kenya.

Indeed, leopards will eat almost any animal available, and this adaptability is perhaps the species greatest strengh apart from it's secretive habits. Moreover because leopards have such a catholic diet they are less seriously affected than other large predators by the decline or dissappearance of populations of any one, or several of their prey species (Hamilton 1981). This opportunistic feeding habit has brought them into direct conflict with cattle farmers and even nowadays into conflict with game farmers.

Over a large portion of their range leopards' natural prey has been reduced to such low levels that they have to utilize alternative prey such as cattle calves. However the fact that cattle calves are an easy prey also eleviates their preference, even in the presence of an abundance of other prey species.

In formulating a cattle calf protection strategy which is one of the crucial components in conserving leopards, information regarding stock capture (such as capture locality, calf size, killing method) and subsequent feeding behaviour (which includes carcass handling) is of the utmost importance. The fact that only one calf out of 19 was killed in a kraal near human activity, shows that the natural tendency of leopards is to avoid such areas of activity.

Leopards in the Waterberg furthermore also selected calves up to three months old. Although calves up to five months have been killed, this seldom happens and can be regarded as very infrequent. This information regarding capture locality and prey age forms an important part in a proposed cattle calf protection strategy (Chapter 6).

This must however be seen against the background of the presence of possible problem leopards. A problem leopard as defined in Chapter 6 as being a troublesome stock-raider who makes a habit of stock-killing and will go to extremes to predate on cattle calves, in the presence of calf protection measures (such as kraals etc.). These leopards can't be accommodated in a calf protection strategy (CPS) and should be destroyed as effectively and quickly as possible. It is hence crucial to react promptly and effectively in eliminating such individuals, without affecting other components of the ecosystem. An appropriate knowledge of the capture and feeding behaviour of a leopard is thus of great importance to first, identify the species involved in the killing, and to subsequently take the necessary action.

In general leopard without exception kill their prey by either strangulation or a bite through the nape of the neck (Turnbull-Kemp 1967 ; own observations). In the Waterberg cattle calves younger than five weeks (n = 7) were killed by means of bites through the nape of the neck. Calves between six and twelve weeks old were strangled (n = 5). These are consistant with the findings of Eltringham (1979) and Bothma & le Riche (1984) who described the predominant killing method to be a throat and neck or head bite.

Black backed jackals may also strangle their prey. Roberts (1986) described the use of distance between upper canines to distinguish between black backed jackals and other predators (dogs) of sheep in Natal. An average of 26 mm was found between puncture holes as caused by the upper canines of black backed jackals (Roberts 1986). Puncture holes caused by Waterberg leopards varied from 38 to 48 mm apart with an average of 44 mm (n = 4).

In contrast to leopards and black backed jackals, brown hyaenas do not go for the throat but rather kill by bites across the rump or on the head and neck. It must however be stressed that brown hyaenas and black backed jackals seldom are involved in cattle calf predation in the Waterberg.

During the three year study period only one calf was believes to have been killed by a brown hyaena. One kill whereby a black backed jackal was involved has been recorded.

The killing method of leopards furthermore enables the possible use of a toxic or lithium chloride (Stream 1976) collar on cattle calves as has been used against coyotes on sheep (Mc Bride 1974). This however needs further investigation before application to the leopard.

In cases where the interpretation of killing methods is not possible due to advanced consumption or putrefaction, the predator involved can fairly easy be identified on feeding methods and/or clues such as spoor and scratch marks. This information can however not ascertain the killer, but merely the feeder. The brown hyaena, unlike the leopard, is a very untidy feeder, and will consume a carcass to the full, including the femur and the head. Black backed jackals also have quite a sistematic way of consuming a carcass (Roberts 1986).

In 24 known kills inspected in the southern Kalahari, hair was licked or plucked away from the body of the prey in five before eating (Bothma & le Riche 1984). This observation agrees with Schaller (1972) and Smith (1977). Hamilton (1976) however found no incidence of hair plucking in Tsavo leopards. In 40 kills inspected in the Waterberg the hair of two impala and three cattle calves were plucked or removed by licking while feeding.

Leopard kills are normally not left in the open like those of black backed jackals and brown hyaenas but are concealed in thick cover or sometimes hoisted into trees. Only five carcasses were left unconcealed under trees in the Waterberg. The rest (n = 35), with the exception of one, were concealed in thick ground cover.

Six of these concealed carcasses were also partly covered with brush or plant litter as found by Smith (1977) in Zimbabwe. In the southern Kalahari Bothma & le Riche (1984), found no evidence of such attempts.

Hoisting of prey items by leopards occurs throughout its range. In Chitawan National Park (Seidensticker 1976) leopards pulled about half of their kills into trees. In the Londolozi Game Reserve, le Roux & Skinner (1989) found 76 % of carcasses being hoisted into trees. As scavengers are fairly low in density in the Kalahari, and as leopards usually kill medium-sized prey which are consumed quickly, they are not bothered by scavengers to the same extent as they would be in more humid areas. Only 17 % of kills (n = 24) were stored in trees (Bothma & le Riche 1984).

In the Waterberg only 2,4 % of the kills (n = 1) were found in trees. Hoisting of carcasses was also found to be uncommon in the Matobo Hills National Park, Zimbabwe (Smith 1977). This as in the Waterberg, supports the conclusion that leopards rarely store kills in an area devoid of large scavengers.

Due to the absence of large predators such as spotted hyaena and lions in the Waterberg (apart from brown hyaenas) leopards did not seem to experience competition from scavengers (Brain 1981). Although no evidence of interactions between leopards and brown hyaenas were found, it is believed that leopards are dominant over brown hyaenas (Mills 1981).

In carrying or dragging the kill to a place of concealment or security, considerable distances are sometimes covered. In the open interior habitat of the southern Kalahari, the mean distance of 410 m (males) and 742 m (females) which leopards dragged or carried prey to suitable cover (Bothma & le Riche 1984) were greater than the average of 120 m (wet season), 260 m (dry season) and 1600 (maximum) reported by Smith (1977) for Zimbabwe leopards.

The capture night dragging distances in the Waterberg varied between 20 m and 1115 m with a mean distance of 650 m. A female leopard dragged a cattle calf 916 m and an impala female 1115 m to two waiting cubs. Second night dragging distances in Waterberg leopards varied from 0 to 350 m with a mean distance of 98 m. Cattle calves were without exception dragged to a vantage point or into thick cover. It seems that the presence of cubs and of human activity in an area, influences dragging distances in the absence of lions and traditional scavengers such as spotted hyaenas.

According to Turnbull-Kemp (1967) the maximum intake of food at any time by leopards is seldom appreciably greater than 20 % of it's body weight in 24h. In Tsavo, Hamilton (1981) measured the daily food intake of leopards of known weight, feeding on baits of known weight. The amount of meat consumed ranged from 2,0 kg to 9,5 kg per leopard per night, with a mean weight of 6,3 kg. Expressed as percentages of the body weights of individual leopards, the amounts eaten on one night represented 4 - 24 % of body weight with a mean of 16 %. Thirteen (62 %) of the meals represented 13 - 17 % of body weight and four (19 %) exceeded 20 % of body weight.

Bothma & le Riche's (1984) data in the southern Kalahari revealed an average daily consumption of some 3,5 kg of meat per day for a male leopard and 4,9 kg per day for females with cubs. Days on which no prey were caught were however included.

In the Waterberg a 60,5 kg radio-collared male consumed an average of 9,4 kg / 12 h (n = 6) during the summer (wet season) and an average of 5,4 kg / 12 h (n = 6) during the winter (dry season). Expressed as a percentage of body weight the amount eaten in one night represented 15,5 % of body weight in the wet season and 8,9 % in the dry season (winter).

A small sample size is involved, and the leopard could possibly have consumed other prey prior to the third calf killed (winter sample) which could have depressed his appetite, so this apparent difference should be treated with caution.

On the other hand, very low night temperatures were experienced (-3°C) at the time when carcass three (winter period) was consumed. These low temperatures delay putrefaction and hence prolong the period of meat availability. This is clearly reflected in the long period spent at the carcass (eight nights). Carcass consumption in the summer months, when insect activity is prominent and putrefaction is much more rapid, did not last longer than four nights (n = 3). This may have influenced rate of consumption. Human disturbance played no role during these periods of carcass consumption.